Department of Energy
Washington, DC 20585

JUL 08 1991

Mr. Frank Foulger
U.S. Department of State
Room 5226 - EUR/WE
Washington, DC 20520

Dear Mr. Foulger:

As you recently discussed with Tom Bell of my staff, this letter is to provide you with information concerning the Hall-Otero Agreement between the United States and Spain, and to make you aware of our plans to provide continued funding and technical support to the Spanish Government in accordance with this agreement. The Hall-Otero Agreement was implemented to provide financial and technical support to the Spanish Government to accommodate recovery from a nuclear weapons accident on Spanish soil in January of 1966.

On January 17, 1966, a U.S. Air Force KC-135 tanker and a B-52 bomber collided during an aerial refueling operation. The bomber, carrying four nuclear weapons, disintegrated over Palomares, Spain, a village of about 1500 people. Two nuclear weapons were recovered intact. The other two weapons experienced nonnuclear detonation of the high explosives, with subsequent burning of fissile material, on impact. This resulted in a fissile material aerosol cloud that contaminated approximately 558 acres of uncultivated, farmed, and urban land. No one on the ground was injured by the incident in Palomares.

The United States, in cooperation with the Spanish Government, initiated Project Indalo, a cleanup operation of the radioactively contaminated area. On February 25, 1966, Dr. John A. Hall, Assistant General Manager for International Activities, Atomic Energy Commission, sent a proposal to Professor Jose Otero, Presidente de la Junta de Energia Nuclear, expanding our collaboration in the fields of health and safety pursuant to the August 16, 1957, United States-Spanish Agreement for Cooperation for Civil Uses of Atomic Energy. Dr. Hall proposed investigating various health and safety aspects of fissionable materials when released into a rural agricultural environment. The agreement was accepted by Professor Otero and resulted in establishing a program of technical and financial assistance to Spain for the radiological followup of Palomares residents and their environment. The project has continued since the Hall-Otero Agreement letter (enclosed) was signed on February 25, 1966. Cooperation continues under the Unites States-Spanish Agreement for Cooperation dated June 28, 1974, which superseded the 1957 agreement and is currently in effect.

Direct funding to the Spanish Government provides supplemental assistance to their environmental surveillance program for Palomares and medical followup of area residents. The U.S. Department of Energy (DOE) also funds Oak Ridge National Laboratory to provide project coordination, technical support, training for Spanish scientists, and scientific equipment.

Responsibility for the project at DOE was transferred to the Office of Health in August 1990. Previous reassignments of project responsibility have resulted in a lack of continued funding for 4 of the past 5 years. Funding for this project is now available for the remainder of this fiscal year and the next fiscal year. In the past, the United States has funded approximately 15-20 percent of the costs of conducting the sampling and bioassay program conducted by the Spanish Government.

We plan to hold a meeting with representatives of the Spanish Government and scientists involved with this project. To the best of our knowledge, a Spanish Government Agency has continued this work on this project despite the lack of recent funding support from the United States. During the meeting, our planned goal is to determine the current status of the Spanish Government activity in this area and financial and technical assistance needed from the United States. It is our goal to develop a five year plan with the Spanish Government to ensure the completion of radiological sampling and decontamination activities of the area. We will keep you advised of our interactions involving the Spanish Government on this project and provide you with copies of correspondence and relevant reports.

We would appreciate any input you may have regarding political sensitivities or contacts to be made at the United States Embassy in Spain prior to our meeting. We plan to execute the funding transfer in August 1991.

Sincerely,

C. Richard Lowe
for

Harry J. Pettengill
Deputy Assistant Secretary
for Health

Enclosure

AGENDA FOR JUNE 12, 1991 MEETING CONCERNING INDALO PROJECT

The following questions are presented to provide a basis for the meeting discussions concerning the Indalo Project.

1. Has the August 16, 1957 Agreement for Cooperation with the Spanish Government, or its successor, expired? Does this have an effect on the Hall-Otero Agreement?

2. Identify additional sources of background information concerning the project, especially the 1966 through 1972 timeframe.

3. Determine if adequate decontamination was initially completed immediately following the accident. Based on current survey results and expanded land usage is additional decontamination needed?

4. Review current Spanish sampling and bioassay plans and the reported delays in counting samples. From this information determine if revisions may be needed in the sampling methodology and the resources available for processing these samples.

5. Obtain Spanish sampling and bioassay plans for the upcoming year and their long term plans and objectives. This will be helpful to DOE in identifying long range support and funding requirements.

6. Determine what the initial goals were for decontamination of the affected areas and the success at meeting these goals. Do these levels meet or exceed current standards?

7. In light of the current situation in the Marshall Islands concerning residual contamination from the nuclear testing program, how politically sensitive is the current situation in Palomares, Spain? What can we do to defuse potential political fallout against the U.S.

8. How much damage has been done to our working relationship with the Spanish as a result of our lack of funding and support of the program during the past three to five years? What do we need to do, in addition to renewed funding support, to regain our credibility with the Spanish?

9. Determine if the advisory panel should be reconvened, and if so the mix of who should be on the panel.

10. Determine the amount of funding to be dispersed to Spain this year and decide if some of the available funds should be held back for next year. Also, decide on the amount of funding to be delegated for ORNL and the advisory panel.

11. Determine how to notify the Spanish Government that the funding for the project is being resumed and arrange for transfer of the funds.

12. Evaluate the need for EH-40 staff to visit Palomares, Spain and meet with the Spanish. Would this help in re-establishing a good working relationship between the Spanish and the DOE project management?

December 10, 1991

Trip Report

Harry J. Pettengill and C. Rick Jones

Travel to Spain on Indalo Project and Participation

in the IV National Congress of the Spanish Society of Radiation Protection

November 23-27, 1991

Purpose:

The purpose of this travel was to meet with representatives of the Spanish Center for Energy, Environment and Technology Research (CIEMAT) in Madrid, Spain on November 23, 1991, to discuss the Indalo Project and for Mr. Jones to continue travel to Salamanca, Spain to present a paper at the First International and IV National Congress of the Spanish Society of Radiation Protection.

Discussion:

November 23, 1991 - Met with Mr. Robert Morris, Science and Technology Counselor, at the United States Embassy Madrid, to discuss the history of and continued involvement of the Department of Energy (DOE) in the Indalo Project with the Spanish Government. The Indalo Project is the code name for the continued environmental surveillance and personnel monitoring program around the community of Palomares, Spain as a result of the atmospheric dispersion of plutonium oxide from the release and subsequent ground impact of nuclear weapons after a collision of a U.S. Air Force B-52 and KC-136 in 1966. The DOE has been working with the Spanish Government to continue this surveillance since the signing of the Otero-Hall Agreement in February 1966.

After briefings and discussions with Mr. Morris we were driven to the Center for Energy, Environment and Technology Research (CIEMAT), the responsible Spanish Government Agency for the Indalo Project. We received a tour of the facilities with each staff member providing a brief discussion of their responsibilities. We were impressed with the breadth of equipment and facilities dedicated to the project. We were then provided a briefing by Mr. Francisco Mingot, Director of the Institute, and his staff on the history and status of the Indalo Project. The following provides a synopsis of the briefing:

- o CIEMAT provides two technical reports and one Annual Report to their Nuclear Safety Council (their governing body). We have requested copies of the last years reports.

- o The population of interest is approximately 800 people and the area of interest is about 223 hectares or 2.5 square Km.

- In 1986 the Palomares population became very vocal about their concerns relative to plutonium in the environment. Since that time CIEMAT has been conducting briefings and communications with the town Mayor and people. This open communications has been successful in allaying the concern of the people.

- CIEMAT is responsible for the technology associated with the Indalo Project and the Regional Health Ministry is responsible for any epidemiologic or health related follow-up.

- A current concern is the redistribution of plutonium oxide in the environment due to encroachment, mainly for farming, into the effected area.

- The minimum detectable levels for CIEMAT analysis of environmental samples and bioassay seemed high. We see this area as one where the DOE can contribute expertise and technology to lower these values.

- The annual Indalo budget consists of the following:

Environmental Analysis	- $300K
Urine Analysis	- $160K
M & A	- $370K
Overhead	- $350K
TOTAl	$1100K

- We were requested to provide between 40% and 50% of the research support for a total annual request for support of approximately $300K. Up to 1988 when funding from DOE ceased the level of funding was approximately $200K so the request appears to be in line. We feel with that sum of support we can enhance the technical capabilities of the Project and translate the technology gained in support of the Marshall Islands program into the Indalo Project. We did however identify areas for future possible cost savings and will pursue those.

- The check for $500K was accepted as payment in full for all past DOE obligations in support of the Indalo Project. This action saved the Department an estimated $100K.

- Within the next couple of weeks CIEMAT will provide us with copies of the viewgraphs they used to conduct the briefing as well as copies of the last years technical and annual reports for our translation into English.

- Within the next couple of months CIEMAT has agreed to prepare a report, in English, that summarizes the activities and findings over the last five years of the Indalo Project.

- It is anticipated that in March 1992, when the summary report is available, CIEMAT representatives would come here for meetings. At that time we will meet with them for 2 to 3 days on the Indalo Project specifically. Then the remaining 2 or 3 days we would have our Marshall Islands contractors in to initiate and facilitate technology exchange across the two programs.

- In September of each year CIEMAT conducts a site visit to Palomares to meet with the Mayor and the people, conduct maintenance on their meteorological and air sampling equipment and tour the area. We have been invited to accompany them on their next trip in the fall of 1992.

November 24 - 29, 1991 - Mr. Rick Jones continues travel to Salamanca, Spain to present a paper and participate in the First International and IV National Congress of the Spanish Society of Radiation Protection. The Congress was attended by over 300 representatives interested in or responsible for national radiation protection standards, policy or guidance development. The afternoon of the first day Mr. Jones presented his paper entitled, "Implications of the ICRP Report 60 Recommendations to the U.S. Department of Energy (DOE)." This presentation was the same information approved for and provided to the Northeast Chapters of the Health Physics Society in April of this year. The paper demonstrates impacts to the older facilities of the DOE costing into the 10's to 100's of millions of dollars from having to adopt a strict annual worker radiation exposure limit of 20 Msv (2 Rem). The only comment received by the audience was a dismissal of the data indicating that the European community was told, by the users, that similar costs and impacts would occur in response to the doubling of the neutron quality factor, yet the impact was never seen.

It became very clear through the conduct of the Congress that the United States is the <u>only</u> developed country that is not prepared to adopt the ICRP 60 recommendations. NRPB in the United Kingdom has already adopted new standards, Canada is in the process, CEC is about to publish the rewriting of their Safety Series, and IAEA and NEA have a collaborative effort to rewrite the IAEA Safety Series. The following observations and recommendations are provided:

- EH-41 should initiate the ALARA Committee to inform line management of these events and establish a strategy to reduce DOE individual annual dose to less than 20 Msv per year. This action should be done prior to restart of existing and new facilities, where possible, to maximize the opportunity for dose savings prior to resumption of normal operations.

- Senior Nuclear Managers should also be informed of these events for their planning.

- NCRP is expected to publish new recommendations shortly. These recommendations are expected to maintain the current 50 Msv (5 Rem) annual limit but place a limit on an individuals cumulative dose to not exceed 10 Msv (1 Rem) times the

individuals age. I personally believe that this is just the first step. International pressure will be placed on the NCRP to also adopt the recommendations of ICRP 60 which will leave the U.S. with the new recommendations of ICRP 60 and a cumulative dose limit on the workers. The DOE should begin now to accommodate these changes through an aggressive ALARA Committee.

- The IAEA is also attempting and has significant momentum to establish mandatory international nuclear safety standards. These mandatory standards would then also be enforceable.

- It is recommended that the U.S. State Department coordinate the conduct of a meeting of the interested Federal Agencies to establish a U.S. position on the ICRP 60 recommendations and the IAEA effort to establish mandatory standards. Meetings are being held internationally, various people from the Federal Agencies are attending meetings representing the U.S. and no "official" position or coordination of the people and their statements has been established.

Summary:

The activities of the Office of Health have been effective in initiating a positive relationship with the Spanish Government for the continuation of the Indalo Project. The funding provided to the Spanish Government was accepted as total payment of past debts thus saving the Department over $100K.

The international radiation protection community has embraced the ICRP 60 recommendations and are in the process of implementing those recommendations in national standards. The U.S. will soon be the only developed country to not adopt the ICRP recommendations. The DOE should establish an aggressive ALARA Committee to develop a strategy to assure accommodation of the ICRP recommendations within 5 to 7 years. The DOE should take an active role to encourage the State Department to develop a national position on ICRP recommendations and the IAEA initiative to develop mandatory nuclear safety standards and coordinate the involvement of U.S. representatives in international meetings.

/s/

C. Rick Jones
Director
Office of Health Physics
and Industrial Hygiene

December 17, 1991

EH-411

Input For Bob Alvarez Briefing On Project Indalo

The Hall-Otero Agreement was implemented to provide financial and technical support to the Spanish Government to accommodate recovery from a nuclear weapons accident on Spanish soil in January of 1966.

On January 17, 1966, a U.S. Air Force KC-135 tanker and a B-52 bomber collided during an aerial refueling operation. The bomber, carrying four nuclear weapons, disintegrated over Palomares, Spain, a village of about 1500 people. Two nuclear weapons were recovered intact. The other two weapons experienced non-nuclear detonation of the high explosives, with subsequent burning of fissile material, on impact. This resulted in a fissile material aerosol cloud that contaminated approximately 558 acres of uncultivated land, farmed land and urban-developed land. No one on the ground was injured by the incident in Palomares. After decontamination operations, about 10 grams of finely dispersed plutonium-239 (Pu^{239}) remained on the soil.

The U.S., in cooperation with the Spanish Government, initiated Project Indalo, a cleanup operation of the radioactively contaminated area. On February 25, 1966, Dr. John A. Hall, Assistant General Manager for International Activities, Atomic Energy Commission, sent a proposal to Professor Jose Otero, Presidente de la Junta de Energia Nuclear, expanding our collaboration in the fields of health and safety pursuant to the August 16, 1957, U.S.-Spanish Agreement for Cooperation for Civil Uses of Atomic Energy. Dr. Hall proposed investigating various health and safety aspects of fissionable materials when released into a rural agricultural environment. The agreement was accepted by Professor Otero and resulted in establishing a program of technical and financial assistance to Spain for the radiological followup of Palomares residents and their environment. The project has continued since the Hall-Otero Agreement Letter was signed on February 25, 1966. Cooperation continues under the U.S.-Spanish Agreement for Cooperation dated June 28, 1974 which superseded the 1957 agreement and is currently in effect.

Direct funding from the U.S. Department of Energy (DOE) to the Spanish Government provides supplemental assistance to their environmental surveillance program for Palomares and medical follow-up of area residents. The U.S. DOE also funds Oak Ridge National Laboratory (ORNL) to provide project coordination, technical support, training for Spanish scientists, and scientific equipment.

The following is a summary of the project support activities provided over the years since the accident by U.S. funding. Continued funding for these activities was provided as requested by the Spanish Government.

1. In Palomares, Spain:
   a. Transportation of Palomares residents to the Center for Energy, Environment and Technology Research (CIEMAT) in Madrid, Spain for periodic medical evaluations.

b. Measurement of soil, air and vegetation samples for plutonium and americium. Also, a limited number of water and animal tissue samples. Many of the archived samples are being measured for Americium-241 (Am^{241}).
c. One staff person is assigned to man the meteorological station and function on site in Palomares.
d. Costs for collecting and processing samples (mainly air, soil and vegetation).

2. In Madrid, Spain:
   a. Costs for support of Palomares residents in Madrid.
   b. Costs for personnel bioassay measurements for Pu^{239} and Am^{241}.
   c. Scientific and support staff to work on project.
   d. Management and administrative costs.
   e. Costs for the assay of environmental vegetation, soil and air.
   f. Assist with the installation and maintenance of equipment.
   g. Obtain and help install equipment at palomares.

3. In the U.S.:
   a. Provide technical assistance.
   b. Provided training with internal dosimetry and dose calculations.
   c. Obtain equipment needed for bioassay labs at CIEMAT.
   d. Provide internal standards for bioassay quality control.
   e. Assist with data interpretation, especially for in vitro counting bioassay.

Responsibility for the project at U.S. Department of Energy (DOE) was transferred to the Office of Health in August 1990. In the past the U.S. has funded approximately 20% of the costs of conducting the sampling and bioassay program conducted by the Spanish Government.

Initial studies carried out during the first several years following the accident have not produced evidence that the distribution of residual plutonium following the clean-up tended to accumulate in specific environmental systems nor that the health of the Spaniards in the area of the impact was either altered or endangered.

The following tables are provided for your information concerning the observed mortality in the Palomares population, the causes of death, and the distribution of cancer other than leukemia in the population.

TABLE 1. DISTRIBUTION OF PERCENTAGE OF DEATHS BY AGE OF THE RESIDENTS OF PALOMARES BETWEEN 1966-1984

Age Years	Deaths Number	Simple Percentage	Total Percentage
Less than 1	3	1.92	1.92
1-10	5	3.20	5.12
11-20	0	0	5.12
21-30	6	3.85	8.97
31-40	0	0	8.97
41-50	6	3.85	12.82
51-60	7	4.49	17.31
61-70	26	16.66	33.97
71-80	51	32.70	66.67
81-90	43	27.56	94.23
More than 90	9	5.77	100.00
	156	100%	

Table 2. CAUSES OF DEATH

Causes of Death	Deaths Number	Simple Percentage
Cancers other than leukemia	18	11.53
Leukemia (*)	3	1.92
Others	135	86.53

(*) Of the deaths from leukemia, one male aged 22, died in Barcelona in 1972, one woman in Palomares died in 1975 at age 21 and another male, also in Palomares died in 1980, at age 9. This later individual was born in France where he lived with his parents until he moved to Palomares, already sick, one year before his death. There is no evidence that their deaths resulted from exposure to plutonium from the Palomares accident.

Table 3. DISTRIBUTION BY TYPES OF CANCER OTHER THAN LEUKEMIA WHICH CAUSED DEATH

Type	Deaths Number	Percentage
Digestive system	9	50.0
Respiratory system	2	11.11
Prostate	2	11.11
Bladder	1	5.55
Uterus	1	5.55
Adenoids	1	5.55
Unspecified	2	11.11

The highest external contamination level measured on the ground was about 81 nanocuries/square meter (nCi/m^2). Some residents of Palomares were measured for internal contamination just after the accident. Measurements of Pu in urine and the body of Palomares residents were started in 1967 at CIEMAT in Madrid and have continued uninterrupted since 1975. In addition to medical examinations, measurements were made to detect Pu and, more recently Am^{241} in the body and in urine. To date 646 people, about 84% of the residents, have been measured at least once. Trace levels of plutonium have been detected in 52 residents that have been checked. Internal radiation doses have been estimated for these levels. The maximum committed effective dose equivalent (CEDE) derived from urine excretion of Pu^{239} was as follows:

Table 4. PALOMARES RESIDENTS MAXIMUM COMMITTED EFFECTIVE DOSE EQUIVALENT

NUMBER OF RESIDENTS	DOSE (mrem) (*)
22	5,000 or less
22	5,000 to 10,000
8	10,000 to 20,000

(*) The doses were estimated by Spanish scientists in Madrid using models and methods provided by Oak Ridge National Laboratory (ORNL). They used the biokinetic plutonium excretion model of Laggett and Eckerman (1987) to estimate intake, and tried to account for both the initial intake and subsequent long-term chronic exposure to airborne plutonium from a very limited amount of bioassay data. The CEDE's were then derived directly from ICRP Publication 30 Supplement tables. This method used to interpret the bioassay data and estimate intakes is conservative, and the Spanish scientists have very likely over-estimated the actual intakes and subsequent internal doses.

By assuming a Gaussian distribution of the urinary excretion values the average excretion rate was found to be 350 femtocuries (fCi)/day. By assuming chronic inhalation of Pu^{239} over the 18 year period and using the standard excretion function for Pu^{239}, one can derive an annual intake level of about 13 picocuries/year (pCi/yr). This is from residual environmental plutonium from worldwide weapons testing and plutonium deposited from the accident. This quantity is equivalent to about 1% of the annual limit for the Spanish public from natural background levels in the environment in other areas of Spain not contaminated by the Palomares accident. The average annual effective dose to the residents of Palomares corresponding to this intake is calculated to be 4.2 millirem/year (mrem/yr).

In discussions with C. Rick Jones, Mr. Alvarez indicated concern over the allegation that a child died of leukemia after soldiers gave the child candy to go around and pick-up bomb parts after the accident. We have researched our records and have found no verification of this incident occurring. However, approximately one hour following the accident over 100 members of the Guardia civil, Spanish police, established an exclusion area around the crash and bomb sites and restricted access of residents to these areas. Also, no Palomares residents were utilized for clean-up of wreckage and bomb debris. However, some Palomares

farmers were hired to assist the Americans in filling drums with low level activity soil and vegetation. Plutonium exposures received by the farmers during this work was very low and did not exceed recommended exposure limits. Therefore, it appears unlikely that a child would have been asked to pick up bomb parts.

Harvey L. Scott
Health Physics Programs
Division
Office of Health Physics
and Industrial Hygiene

APPENDIX I

In a study conducted by G. Voelz and J. Lawrence concerning medical follow-up of Manhattan Project plutonium workers, 26 white male subjects who worked with plutonium during World War II at Los Alamos National Laboratory were studied. They received periodic medical examinations over a period of 42 years to identify potential health effects. Inhalation was considered to be the primary mode of plutonium exposure for these workers. Estimates of individual plutonium depositions, including lung burdens, as of 1987 or at the time of death range from 1.4 to 86 nanocuries (nCi) with a median value of 13.5 nCi. Four persons from the original group had died as of 1987. The causes of death were lung cancer, myocardial infarction, accidental injury, and respiratory failure due to pneumonia and congestive heart failure. Subsequent to 1987, three additional deaths occurred from arteriosclerotic heart disease, lung cancer and osteogenic bone sarcoma. This appears to be the first case in which a bone sarcoma has been reported in a person exposed to plutonium. The estimated plutonium disposition in this man at the time of death is 15 nCi. However, while working at Los Alamos in August 1945 he received a wound to his thumb that became contaminated with a plutonium solution. The wound resulted in an uptake of approximately 2 nCi of plutonium. None of these workers have been diagnosed with leukemia. The plutonium exposures of these Manhattan Project workers expressed in terms of their CEDE, ranged from 10 to 850 rem.

Of approximately 400 beagle dogs, used in life-span studies and exposed to insoluble plutonium oxide or soluble plutonium nitrate at Pacific Northwest Laboratory (PNL) between 1960 and 1975, none have had leukemia. Intakes ranged from a few nanocuries to about 10,000 nanocuries of Pu^{239}. Lung tumors were observed, increasing with exposure, in dogs exposed to Pu^{239} oxide, and bone tumors were observed in dogs exposed to Pu^{239} nitrate. Both lung tumors and bone tumors were observed in dogs exposed to Pu^{238} oxide, a form that is more easily transported because it has a

the bioassay data are comparable to the collective CEDE these same peo received from natural background radiation. The most highly exposed persons are estimated to have received ten times more dose from Pu tha from natural background during a 15-year period.

Collective CEDE (a simple summation of everyone's) from plutonium exposure among those 516 Palomares residents whose urine results were "below detectible" can be estimated by assuming a lognormal distributi The collective CEDE is then estimated to be about 900 person-rem.

The potential radiation doses were calculated from exposure to the environmental levels of plutonium from data published in Iranzo, et al (1987). The reported soil contamination at air sampling station 2-2 i Figure 1 of that article (which appears to be the location of the near house downwind) was 3.2 microcuries/square meter (This surface contamination was assumed to exist at the start of the exposure period with no reduction from cleanup, but with reduction for leaching to low soil depths. All of the plutonium was assumed to be finely divided Pu on the soil surface. Re-suspended Pu was assumed to be class Y, but t Pu^{239} in foods was taken to be class W as recommended by the ICRP (1986) Doses calculated were 50-year CEDE values accumulated from 50 years of intake of the Pu. Doses were calculated using Version 1.485 of the GE software package (Napier, et al. 1988). The calculated cumulative radiation dose was 5 rem; and the CEDE from the first year's exposure 3 rem. This result is in the range of some of the doses calculated fr the bioassay data.

For comparison, doses were calculated based on 50 years of exposure to the average air concentration reported by Irenzo, et al. 1987) for air station 2-2 located near the 3.2 microcuries/square meth. The reported 15-year average concentration was 5 x 10^{-5} becquerels/cubic meter (Bq/m This result is much lower than the doses based on either the soil contamination data or the bioassay data.

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